Whitepaper

Personnel Functional Safety Certification: Not All Programs Are Created Equal

Summary

As production runs ever closer to equipment and facility operating limits and new plants come on line in expanding and developing economies, the pressure to design and operate systems more safely and economically is increasing. A key to meeting this goal is having competent people who are knowledgeable and experienced in applying the IEC 61508 and IEC 61511 / ISA 84 functional safety standards. To develop and measure an individual's safety engineering competence, several personnel functional safety certification programs have been created.

This paper will discuss why these programs are needed and the benefits they deliver to individuals and companies alike. It will also review the characteristics and differences of the various certification programs on the market today, things to watch out for, and some important questions to ask when selecting a certification program.

Table of Contents

Why Personnel Functional Safety Certification Programs are Needed

The publication of the international functional safety standards IEC 61508 (1999), IEC 61511 / ISA-84 (2004) and IEC 62061 (2005) were significant milestones in the effort to increase equipment and process safety.[1,2,3] Unfortunately release of safety standards does not by itself make the world a safer place. The catastrophic process safety incidents at Bhopal (India), Buncefield (UK), and Texas City (USA) serve as reminders of what can happen when things go horribly wrong. They also highlight the importance of having personnel who are knowledgeable and competent in functional safety.

Analysis of past process safety incidents underscores the role that people can play in preventing these accidents. A study by the UK's Health and Safety Executive (HSE) showed that most safety incidents could have been prevented. It concluded that accidents are primarily the result of poor decisions during the various phases of a plant's life (design, installation & commissioning, operation, and maintenance), but that the majority can be traced to errors related to design. It found that the number one cause of accidents was incorrect and incomplete design specification (44%). Another 15% was from improper design & implementation. The study also found that a significant percentage of incidents were caused by changes made after commissioning (21%), as well as errors during operation and maintenance (15%). [4] A subsequent study on accidents in the chemical sector found that three most common causes of failure were errors in operating procedures (37%), in plant design (32%), and in hazard analysis (26%). [5]

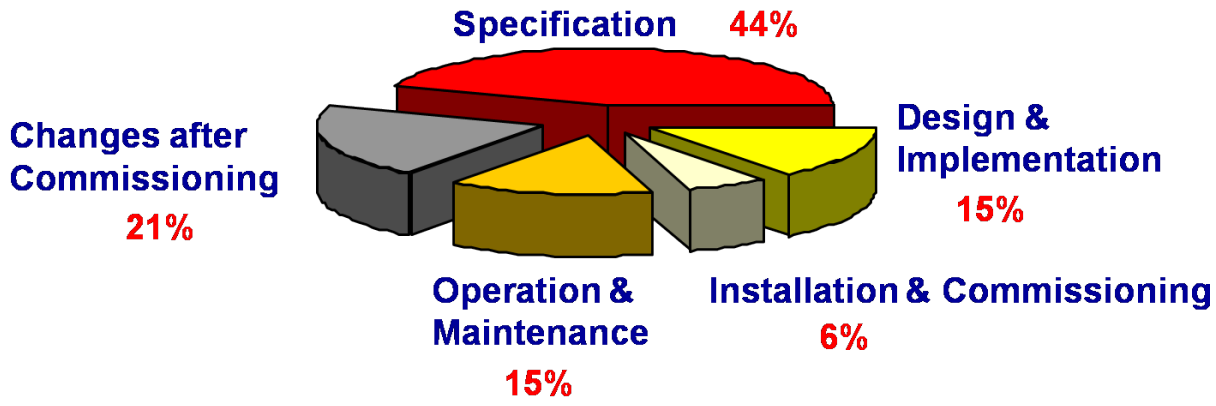

Figure 1 – Results of HSE Study [4]

Exhaustive analysis of process plant disasters by Trevor Kletz concludes that all accidents are traceable to human error in some form. His studies pinpoint the major areas for improvement where better knowledge, training, and execution could have prevented safety incidents as follows [6]:

- process design (60%)
- hazard and operability studies (50%)
- operating procedures (33%)
- training and human factors -to eliminate operator errors (20%)
- inspection (16%)
- mechanical design (10%)

Personnel Functional Safety Certification programs are designed to address these shortcomings by improving the safety design knowledge and practices of individuals who are involved with the design and operation of critical equipment and processes.

The Human Element of Functional Safety (The Challenge)

The analysis of past safety accidents was conducted primarily in regions and with companies which had an "experienced" workforce. Today the global economy is undergoing major shifts in manufacturing which are making the issue of finding, developing, and retaining experienced people more challenging than in the past. In "Brownfield" (developed) areas, like North America and Europe, it has been estimated that some 30% of the core knowledge staff within the process industries will retire within 5 years, taking a large amount of engineering and operating experience with them.[7] Additionally a major petrochemical company expects 50% of its engineering workforce to retire in the next five years.[8]

There is already a shortage of engineers with relevant expertise. Engineering enrollments have been down for significant periods over the last 25 years. This is exacerbated by the fact that many engineers don't consider process industry or manufacturing jobs to be attractive anymore, especially since many of them are in inhospitable places.

Couple the shortage of experienced and knowledgeable workers with the way plants are being designed and run today and we have the potential for the number of accidents to increase rather than decrease. Existing operating units, many of which are over 40 years old, are being run at maximum capacity with extended run lengths. In developing areas of the world, economic expansion means more and more new plants (e.g. power generation) to keep up with the growing economy. With such a high percentage of new industry, these developing areas often lack the depth of experience present in the traditionally developed regions of the world. Taking part in a program designed to build functional safety competence in key resources is one way for companies around the world to overcome these challenges.

Competence is a Requirement (Not an Option)

Having people that are competent in functional safety isn't just a good idea it is **required** by the international functional safety standards IEC 61508 and IEC 61511 / ISA-84. These standards both contain **requirements** for having competent and trained personnel to carry out the safety life-cycle activities (design, installation & commissioning, operation, and maintenance) that are documented in them. These standards are widely recognized as good engineering practice and they have become the benchmarks by which governments now measure a company's behavior in the event of an incident.

> IEC 61511 – "Persons, departments or organizations involved in safety life-cycle activities shall be competent to carry out the activities for which they are accountable" – IEC 61511, Part 1, Paragraph 5.2.2.2

> IEC 61508 – "…ensuring that applicable parties involved in any of the overall E/E/PE or software safety lifecycle activities are competent to carry out activities for which they are accountable" – IEC 61508, Part 1, Paragraph 6.2.1 (h)

The Origin of Personnel Safety Certification Programs (Safety Certification to the Rescue)

Having trained and competent safety practitioners is in the best interest of a company and is required by international functional safety standard. So now you might ask… how does a person become competent in functional safety? How is functional safety competence measured and who does the measuring?

As a result of the competency requirement in the standards, several personnel functional safety certification programs have been created. The first such program, the Certified Functional Safety Expert (CFSE), was launched in 2000 as a collaboration between two leading certification companies, exida and TÜV Sud, and then was expanded into the non-profit CFSE Governance Board consortium in 2002. In 2004 the Functional Safety (FS) program was introduced by TÜV Rheinland. In 2008, ISA launched their ISA 84 Expert program while TÜV Sud launched the Functional Safety Certification Program (FSCP). The goal of each program is to help individuals develop/enhance their competence in functional safety and provide a means of measuring (testing) it.

Focused programs have been developed to address different personnel skillsets and levels of expertise (e.g. “practitioner” vs. “expert”), as well as different applications in the area of functional safety.

- Process Safety
- Machine Safety
- Safety Hardware Development
- Safety Software Development

Benefits

Functional safety certification programs deliver benefits to both individuals and companies.

For companies it provides the proof of competence demanded by safety standards and the confidence that their personnel have truly mastered a proper understanding of functional safety and the safety lifecycle. It is also a critical step in developing and demonstrating a “safety culture” within an organization. Completing the certification ensures that an individual has met a minimum level of competence, which is important for employers as they seek personnel with the necessary skills and training. The act of relying on certified personnel can boost a company’s reputation as it signifies a commitment to professionalism and expertise. This may be why one supplier to the process industries has used the achievement of safety certification as a Key End Result worthy of a financial bonus for their employees. Most importantly, using certified safety experts can help companies save money by simplifying regulatory compliance, reducing engineering costs, preventing unplanned downtime, and ensuring that safety systems are neither over-designed nor under-designed.

For individuals, following the recommended training curriculum will increase their functional safety skills and knowledge and making them more valuable to their employers / potential employers. This helps individuals differentiate themselves from other workers on the market resulting in greater promotional opportunities and salary increases. Demonstrating competency through quality certification programs opens doors to employment, advancement, leadership, contracts and compensation. Increasingly companies are requiring certified personnel to oversee safety projects, particularly those where new infrastructure is being created (e.g. in the Middle East and Asia Pacific regions).

How to Select a Certification Program (The Importance of Doing Your Homework)

Understanding the nature of the certifying body and the quality of the certification process is important to ensure that the expected benefit is received. An individual who bears a designation but appears unable to perform competently is often referred to as a "paper tiger" because their resume suggests that they are more effective than they really are. To protect the public from under-qualified or unqualified workers, the American National Standards Institute (ANSI) announced its intent to launch an accreditation program for organizations that certify personnel. "The quality of certificate programs in the United States varies widely," explained Lane Hallenbeck, ANSI vice president of accreditation services. "It is becoming increasingly difficult for consumers, employers, government agencies and others who rely upon a skilled workforce to identify which certificates are legitimate." [9]

Another reason for evaluating the quality and structure of a certifying body is to learn how certification from their program will be accepted and looked upon by companies and government entities in different regions of the world.

Certifying the Certifiers

Certifying personnel, particularly in the area of functional safety, is a business that requires a significant level of commitment and expertise from the certifying party in order to create an effective program. Not just any company or organization can become a functional safety certifying body, which is good, because proper certification can mean the difference between life and death if the safety standards are not followed correctly.

ISO 17024, released in 2003, is an international standard which sets out criteria and provides a framework for an organization's certification of individuals. It is designed to harmonize the personnel certification process worldwide. According to ISO 17024, competence can be defined as the demonstrated ability to apply knowledge and skills in addition to demonstrating personal attributes.

The standard is particularly applicable to functional safety certification. It contains several key requirements which can be used to assess the quality of a functional safety certification program.[10]

- **The examination must be independent.** – "*The certification body shall not offer or provide training, unless it demonstrates how training is independent of the evaluation and certification of persons*" [Ref IEC]. This means that examiners should not be involved with the pre-exam activities (such as training).

- **"Examinations shall be fair, valid and reliable".**[10] One can infer that this means that examinations from a certifying body should be consistent between regions of the world no matter who is administering the exam. (i.e. Exams should have the same number, type and difficulty of questions, the same format, same passing grade…)

Certification vs Certificate Program: Is there a Difference?

Understanding the difference between a certification program and a certificate program is critical to assessing the quality of a given program. In a ***certification*** program the applicant must pass an examination based on broad industry knowledge that is independent of training courses or course providers. ***Certification*** generally refers to an earned credential that demonstrates the holder's specialized knowledge, skills, and experience. It is designed to measure an individual's "knowledge-in-use", which can be defined as the application of knowledge and skills by those with real-life experience in this role. Certification differs from a ***certificate*** program, which is usually an educational course offering that confers a document at the program's conclusion. In a certificate program, the applicant must attend a particular course and pass a test based on the material from the course.

Certification	**Certificate**
Results from an assessment process that recognizes an individual's knowledge, skills and competency in a particular specialty	Results from an educational process
Typically requires professional experience	For newcomers and experienced professionals
Awarded by a third-party, standard-setting organization, typically not for profit	Awarded by educational programs or institutions often for-profit (commercial)
Indicates mastery/competency as measured against a defensible set of standards, usually by application or exam	Indicates completion of a course or series of courses with a specific focus (different than a degree granting program)
Standards set through a defensible, industry-wide process (job analysis/role delineation) that results in an outline of required knowledge and skills	Course content determined by the specific provider or institution, not standardized
Typically results in credentials to be listed after one's name	Usually listed on a resume detailing education
Has on-going requirements in order to maintain; holder must demonstrate he/she continues to meet requirements	Demonstrates knowledge of course content at the end of a set period in time

Table 1. Differences between Certification and Certificate Program [11]

You might ask why it is important to understand the distinctions between a certification program vs. a certificate program. The differences show up in the rules and privileges for how one may use the term “certified” in describing their credentials. These can differ on a region by region basis. The ANSI/NOCA Standard 1100, published in March 2009, stipulates that holders of training **certificates** may NOT use letters or acronyms behind their names, nor may they use the word “certified” in describing their credentials. [12] The use of letters, acronyms and the word “certified” are reserved for holders of professional **certifications** as defined in the standard. Therefore it is possible that someone who passes a certificate program may not be able to display a designation on their business card or in email signature. This could be very disappointing to someone who completes a **certificate** program thinking that it is a **certification** program and expecting the associated benefits. It could be even worse for a certificate holder who chooses to ignore these requirements and fraudulently uses certification type designations.

The following questions can be used to quickly determine whether a specific program is a certificate or certification program. If the answer is “Yes” to either question, then it is a certificate program.

1. Does the certification body or its paid agents develop or deliver its own certification prep courses?

2. Does the certification body require its own or its own paid agents’ prep course as a prerequisite for certification, or imply that such a course is the only way to certification?

What's in a name? - Beware the Use of the Term "Engineer"

The use of the term "engineer" in a professional certification or title can be problematic. In many regions of the world there are restrictions and regulations on exactly how this term may be used. The laws in some regions require that a person has received an engineering degree to be able to be certified as an engineer. Other regions' laws mandate that to be called a certified engineer, the applicant must have passed a specific professional qualification exam (usually administered by a government entity). Therefore it is important to understand what title or credentials are being granted by a program and how these may be applied in a region of interest.

Several licensing bodies for professional engineering contend that only licensed professional engineers are legally allowed to use the title "Engineer". In Continental Europe, Latin America, South America, and Turkey, the title "engineer" is limited by law to people with an engineering degree, and the use of the title by others (even persons with equivalent work experience) is illegal. Thus programs that permit granting of engineer credentials to persons without an engineering degree may be in conflict with the law in certain regions of the world. [13]
In Italy the title is limited to people who, besides holding an engineering degree, have passed a professional qualification examination (*Esame di Stato*). In Chile, the *Ingeniero* (engineer) title is also regulated by law. In Brazil the title of *Engenheiro* (engineer) and in Argentina the title of *Ingeniero* can only be legally used by someone with a five-year engineering degree.

Restrictions and regulations on usage also exist in North America. In Canada, the usage of the term "engineer" to describe holders of professional certification is not legally permitted. It is protected by the Engineers act of the province, which requires registration with the provincial engineering professional organization (e.g Ordre des Ingénieurs in Quebec, or Professional Engineers Ontario (PEO) in Ontario). The Canadian Council of Professional Engineers mounted a successful campaign to have Microsoft renounce the use of the word "engineer" in their MSCE designation.

The title "Engineer" is legally protected in many US states, meaning that it is unlawful to use it unless permission is specifically granted by that state, through a Professional Engineering license. In Texas for example, a person may not use the term "engineer" in their identification, name, or title unless they have been issued a license under Texas Occupations Code, Title 6, Chapter 1001 .

Ten Questions to ask when Selecting a Certification Program

This section provides a list of questions that can be used to evaluate the structure and quality of a certification program in order to select the best program for an individual or company.

1) **Are there different certification levels available? What are the specific qualifications and application requirements for each?**

   Most programs provide multiple certification levels in different areas of functional safety. The levels are targeted at people with different responsibilities (practitioner vs. expert vs. developer) and will have different educational and experience requirements. The process and level of effort for completing an application typically differs based on the certification level. The "expert" certifications typically require the applicant to provide references and case studies as part of the application process. Lower level certifications require much less (e.g. education and employment history). Choose the one that best lines up with your roles and responsibilities, as well as your skill set.

2) **Is taking a specific training class required as part of the certification process or can I just sit for the exam ?**

   Certificate programs require the applicant to take a specific class and then pass a test based on the material covered in the class. In a certificate program it is not possible to take the exam without first completing the training class. The cost for a "required" training classes can often be expensive. Beware of "certificate for sale" programs. A certification program on the other hand measures the individual's "knowledge in use"; therefore it is possible to sit for the examination without completing any specific training class.

3) **Is this a certification program or a certificate program ?**

   In some countries certificate holders are not granted the same rights as certified personnel when it comes to display and use of their title. It is important to check with your local region to understand the rules of usage. To many employers, personnel certification is held in higher regard than certificate programs.

4) **Is the organization providing the certification an independent, non-profit organization?**

   This information helps to understand the motivation and philosophy of the organization. Chances are if they are non-profit organization (which one can tell because their website address ends in ".org") their main goal is improving industry knowledge, skills and competence. In a commercial (for-profit) program, the goal of improving competence must be balanced by the need to generate a profit.

5) **Is the examination identical for all regions (other than translation into the local language)?**

   A certification where the written examination is developed and delivered locally in each country could be inconsistent from region to region, particularly if it contains a different numbers of questions and/or the format varies (# of multiple choice questions vs # of working problems). There could also be significant differences if the exams are not independent of vendor equipment (e.g. a specific brand of SIS). These scenarios would violate the IEC 17024 standard, which states that examination procedures should ensure a uniform application and be free from bias. It would also mean that certifications received in different countries may not be comparable – one version of the exam may require demonstration of a lower level of competence than another.

6) Is the organization made up of an independent board? What companies are on the board?

An organization that has an independent board made up of suppliers, end-users, integrators, and consultants is most likely to continuously improve the certification program and make sure that it meets the needs of its constituents.

7) Who makes up the examination questions?

Test questions should be formulated by a team consisting of members of the board and industry representing end users, integrators, consultants, and suppliers. Questions should be created after performing a job / practice analysis which establishes the important and critical tasks performed by competent people working in the profession. This effectively defines the knowledge base to be tested.

8) Who teaches the preparation class? Who grades the examinations? Do the same people teach the prep class as grade the test ?

According to the IEC 17024 standard for personnel certification, it is important that the people who teach the preparation class are independent from those that grade the exam. Requiring that course instructors do not grade exams of their students ensures that independence and impartiality are not compromised. Maintaining confidentiality is also an important requirement of IEC 17024, particularly when it comes to the grading of examinations. Some programs use an independent double-blind two step grading process where two graders are randomly selected from a pool of qualified graders. The applicant's identity is then also hidden from the graders.

9) Are the members of the training organization you may use experts in the field? Have they written books or published technical papers on the subject? Do they provide safety lifecycle engineering services to end users? Do they perform safety certifications of automation equipment?

Functional safety is a broad and diverse subject. Working with a training organization made up of experts in all facets of functional safety can have its benefits both in terms of improving your chances at earning the certification and in terms of mastering the material. Look for training organizations that have broad and deep experience to ensure that you are getting the best "education" as part of the certification process.

- delivering safety lifecycle services to end users
- certification of supplier design and engineering processes
- safety certification of devices per IEC 61508
- involvement in safety standards development
- creation and application of engineering tools to support the safety lifecycle

10) How are applicants screened ? Can a person without enough experience pass the exam?

Some programs do not require applicants to complete their applications prior to sitting for the exam. This could result in situations where persons who do not meet the minimum education and experience levels pass the exam…What does this say about the quality of the exam and the program?

Summary of Certification Programs

Selecting a certification program can be a challenging task. The information in Table 2 and Appendix B has been compiled to help you compare and contrast the various programs available and determine which one is best for you. Each program offers both an expert level certification or certificate and a practitioner level certification or certificate. The practitioner level is targeted at individuals who deal with functional safety on a project-by-project basis. The expert level is aimed at personnel who are responsible for leading, coordinating, and reviewing the activities of the safety lifecycle and who deal with functional safety on a daily basis.

	CFSE	ISA	TÜV Rheinland	TÜV SUD
Program Name	Certified Functional Safety Expert	SIS Certificate / Expert	Functional Safety Program	Functional Safety Certification Program (FSCP)
Expert Level Certification	Certified Functional Safety Expert (CFSE)	ISA 84 Expert	Functional Safety Expert (FSExp)	Functional Safety Expert (FSE)
Practioner Level Certification	Certified Functional Safety Professional (CFSP)	SIS Fundamentals Specialists (SFS)	Functional Safety Engineer (FSEng)	Functional Safety Professional (FSP)
Organization Status	Non profit	Non profit	For-Profit	For-Profit
Origination Date	2000	2008	2004	2008
Training / Prep Course	Recommended	Required	Required	Required
Training Provider	exida offers training but no specific course is required	ISA	Local Partners - Premier (US), ACM (CA) , C&C (UK) and TÜV Rheinland (Machine Safety & HW, S/W Development)	Local Partners - Risknowlogy, TUV SUD, FS Engineering VP, Safety Users Group
Submit Credentials	Before Exam	Before Exam	After Exam	
Exam is identical for all regions	Yes	Yes	No	TBD
Exam Questions	Created by CFSE Board	Developed by ISA	Developed by Local Partners - Premier (US), ACM (CA) , C&C (UK)…	Developed by Local Partners ??
Exam Graders	CFSE Board	ISA	Local Partners - Premier (US), ACM (CA) , C&C (UK)…	
Governance Board	Emerson, exida, PILZ, TUV Nord	TBD	Interest Group consists of HIMA, PCS, Honeywell, ACM, ICS Triplex, Siemens, Rockwell, Yokogawa, DOW, Innotec, ABB,	Course providers and end users
Program Type	Certification	Certificate	Certificate	Certificate
Org Website Address	www.cfse.org	www.isa.org	www.tuvasi.com	www.tuev-sued.de

Table 2. Comparison of Functional Safety Programs [14,15,16,17]

The purpose of all functional safety certification and certificate programs is to build and measure competence. Each program accomplishes this to a different degree as shown in Figure 2. Programs differ greatly in their requirements for years of experience and in the level of competency demonstrated. The competency demonstrated has been assessed based on the relative degree of difficulty in passing the examination (is the test easy or challenging) as reported by individuals who have participated in multiple programs. Some programs require a higher level of competency to be demonstrated in order to receive the certification.

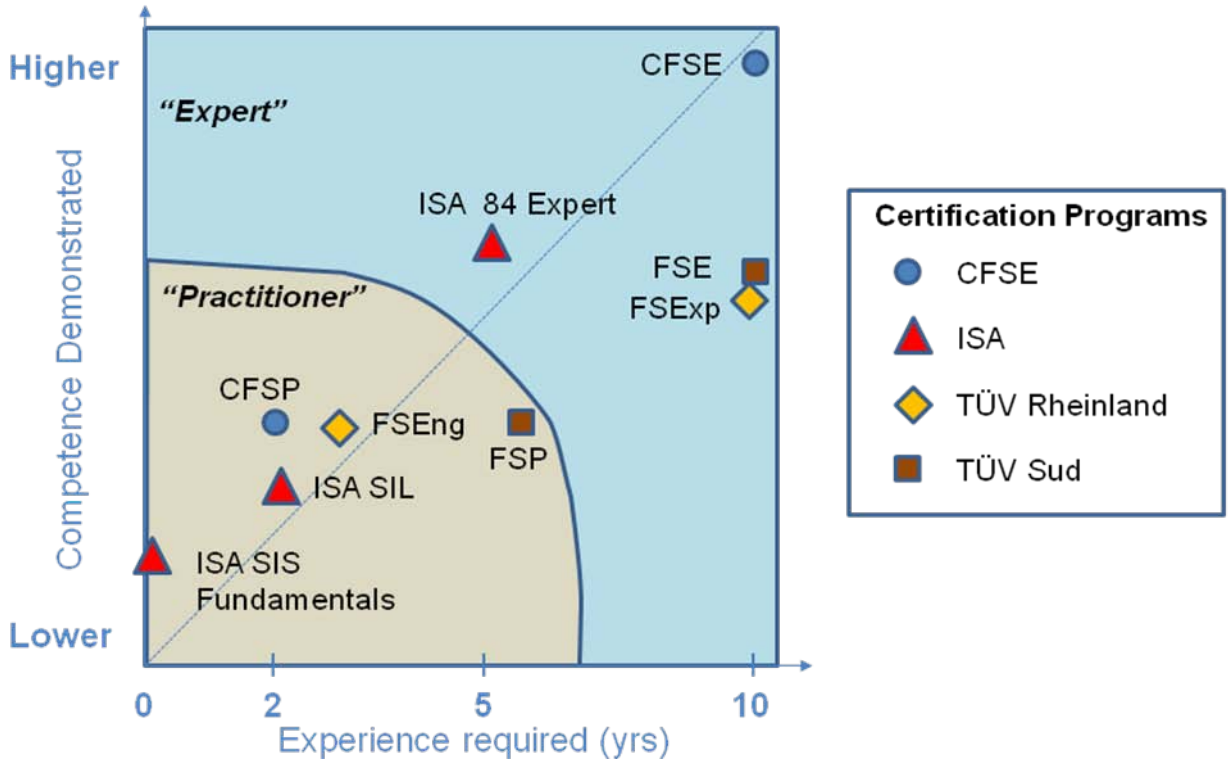

Figure 2 – Comparison of Competency Demonstrated vs. Required Experience [18]

Conclusion

Improving the safety of operating plants and new installations is becoming increasingly important to companies and governments alike. Personnel Functional Safety Engineering certification programs provide a means for acquiring knowledge and skills, and for demonstrating the proof of competence that is demanded by the IEC 61508 and 61511 standards. These programs can reinforce lessons learned from past accidents and can help address the shortage of qualified personnel due to changes in workforce demographics.

Not all certification programs are created equal. Performing a thorough evaluation is highly recommended when selecting a program. For example some programs are more accurately characterized as certificate programs, which may have a different level of acceptance by companies and governments. Programs differ widely in the level of competence that must be demonstrated to become certified. This paper has provided a series of questions that can be used to help select the best certification program for different individual requirements.

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Appendix A: Safety Competence Requirement from IEC 61511

5.2.2.2 Persons, departments or organizations involved in safety life-cycle activities shall be competent to carry out the activities for which they are accountable.

NOTE As a minimum, the following items should be addressed when considering the competence of persons, departments, organizations or other units involved in safety life-cycle activities:

a) engineering knowledge, training and experience appropriate to the process application;
b) engineering knowledge, training and experience appropriate to the applicable technology used (for example, electrical, electronic or programmable electronic);
c) engineering knowledge, training and experience appropriate to the sensors and final elements;
d) safety engineering knowledge (for example, process safety analysis);
e) knowledge of the legal and safety regulatory requirements;
f) adequate management and leadership skills appropriate to their role in safety life-cycle activities;
g) understanding of the potential consequence of an event;
h) the safety integrity level of the safety instrumented functions;
i) the novelty and complexity of the application and the technology.

Appendix B – Detailed Comparison of Personnel Functional Safety Certification Programs

	CFSE	ISA	TÜV Rheinland	TÜV SUD
Expert Level	**Certified Functional Safety Expert (CSFE)** • 10 years experience • 4 references • Case study • Resume & experience (technical degree, publications, etc.) • 4-day optional preparatory course available ($2195) • Exam required (1-day) • Exam Cost $800	**ISA 84 Expert** • 5 years industry experience • 2 years PHA / SIL selection experience • 2 years SIL verification (and/or other related) experience • Take all three ISA SIS courses (totaling 7 days) on fundamentals, SIL selection and SIL verification • Take all three ISA exams (each exam has 75 questions)	**Functional Safety Expert (FSExp)** • 10 years experience • 2 case studies • 2 external references • Resume & experience (technical degree, publications, etc.) • *No exam required*	**Functional Safety Professional (FSP)** • 10 years experience • 2 case studies • Resume & experience (technical degree, publications, etc.) • Must fulfill FSE requirements (below)
Practitioner Level	**Certified Functional Safety Professional (CFSP)** • 2 years experience • 4 references • Resume & experience (technical degree, publications, etc.) • 4-day optional preparatory course available ($2195) • Exam required (1/2-day) • Exam Cost $700	**SIS Fundamentals Specialist (SFS)** • No experience requirement • No references required • 3-day preparatory course required • Exam required (2-hours, 75 questions) • Course and exam approximately $1,700 for each of three courses	**Functional Safety Engineer (FSEng)** • 3 years experience • 4 references • Resume (technical degree, etc.) • 3 - 4 day preparatory course required • Exam required (1/2-day) • Course & exam approximately $2,950	**Functional Safety Expert (FSE)** • 6 years experience • 2 references • Resume (technical degree, etc.) • 2 – 3 day preparatory course required • Exam required (1/2-day) • Course & exam approximately $2,850
Prep / Training Course	A preparatory course is *not* required to take either exam.	Taking the ISA courses is required before taking the exams. Students have up to 3 months after a course (to study) before taking the online exam.	Taking an FSEng course is required before taking the exam (the next day). If someone fails the exam, they may only retake it after retaking the course.	Taking an FSE course is required before taking the exam (the next day).
	Courses are available from several providers. Each has been reviewed and approved for use by the CFSE Board.	ISA courses are standardized.	Experts develop and teach the courses independently. Courses will differ, but are reviewed by TÜV.	